



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

**GEOLOGY OF THE MUSSEL-BEARING CLAYS OF FISH-HOUSE,  
NEW JERSEY.**

BY HENRY A. PILSBRY.

The deposit containing fresh-water mussels of the genera *Unio* and *Anodonta*, situated at Fish-house, Camden County, New Jersey, on the Delaware River, about 5 miles north of Camden, was first noticed, so far as we know, by Professor E. D. Cope, who placed a series of the fossil *Unionidæ* in the hands of Dr. Isaac Lea for description<sup>1</sup> in 1868. In Dr. Lea's paper the bed containing these remains is said to be "subordinate to the Green Sand \* \* \* \* belonging to that portion of the cretaceous group which furnished \* \* \* \* *Hadrosaurus Foulkii* Leidy," etc.<sup>2</sup>

The species of *Unionidæ*, twelve in number, were fully redescribed and illustrated in 1886 by Professor R. P. Whitfield,<sup>3</sup> who, relying upon the above statement in Dr. Lea's paper, considers the deposit as "from near the base of the Cretaceous series of the State." Professor E. D. Cope,<sup>4</sup> in a brief consideration of "The Fresh-water Clays of the Pea Shore," in 1869, gave an excellent section of the beds, which may be consulted with advantage in connection with the present communication. He held that they were "much later" than the Cretaceous, and, in fact, Pliocene; basing this conclusion largely upon the finding of a large part of the cranium of a horse believed to be *Equus fraternus* Leidy. The late H. Carvill Lewis, on the contrary, held the Fish-house clay to be "of interglacial age,"<sup>5</sup> and this estimate of the age of the deposit is shared by Dr. C. A. White,<sup>6</sup> who considers the fossils as of post-Tertiary date. This is also, I believe, the opinion of most Philadelphia geologists who have recently examined the subject.

---

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., 1868, p. 162.

<sup>2</sup> It is difficult to account for this statement, which finds no justification in the stratigraphy of the region in question, so far as I can see.

<sup>3</sup> Brachiopoda and Lamellibranchiata of the Raritan Clays and Green Sand Marls of New Jersey, pp. 243-252.

<sup>4</sup> Trans. Amer. Philos. Soc., XIV, N. Ser., pp. 249, 250.

<sup>5</sup> Professor Lewis did not, I believe, formally publish this view, but taught it in his lectures at the Academy of Natural Sciences of Philadelphia, synopses of which were published in the "Public Ledger," April-June, 1884. The above quotation is from one of these newspaper reports.

<sup>6</sup> A Review of the Non-Marine Fossil Mollusca of North America, 1883.

The view that the Fish-house clay is of Pleistocene age is materially strengthened by the discovery therein of several horse teeth by Mr. Lewis Woolman, and by the recognition of the identity of at least a portion of the *Unionidae* with living species, a subject referred to below.

The fossils occur only in a layer of black clay, which is used for brick and tile making. This deposit is capped by a layer of coarse sand. Under the black clay is a much thinner stratum of yellow or reddish clay, containing considerable sand and deeply stained with iron oxide. Below this stratum, which is about two feet thick where observed, there is coarse gravelly sand, which forms the foundation of the superimposed clays. This sand deposit is of considerable thickness, and the various sections exposed show it to be distinctly stratified, the strata being obliquely laminated, as shown in the annexed diagram. The character of these strata is completely that of arenaceous deposits in river-beds. So far as I know, such a disposition of the materials is not produced by any other means. No such stratification and oblique lamination is

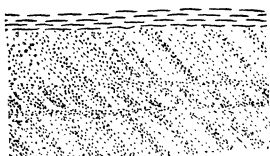


FIG. 1.  
Obliquely laminated strata.

to be seen in the coarse sand at the summit of the clays. This difference indicates a diverse origin for the two deposits. In the opinion of the writer, the peculiarities of the Fish-house clays may be explained by the supposition that the deposit has been purely a result of river-action. The phenomena are exactly paralleled by processes now in progress in the rivers of the Mississippi system, where similar deposits containing a similar fauna may be seen in every stage of formation.

Upon this theory the sands underlying the red clay were deposited in a former Delaware River bed, the river at that time flowing in a direction practically parallel to its present course, as shown by the direction of the oblique lamination of the strata. A change in the river's course, such as cutting across the neck of an "ox-bow," or some similar shifting, left the former bed at this point a lagoon, similar to the so-called "sloughs" of the Mississippi River. A lagoon of this nature, while it quickly becomes dammed at the upstream end, for a time receives a portion of the current in time of high water. In the case under consideration, the layer of red, more or less arenaceous, clay was probably deposited during this period of

partial isolation. Further separation of the slough from the stream is effected by the growth of willows and other vegetation upon the alluvial ridge at its head, which rapidly gains in height by the debris collected thereby. The lagoon of quiet water thus formed is a very favorable station for molluscan and other aquatic life, sedentary animals, or those of weak locomotive powers becoming far more numerous than in the active current of the parent stream. Such a lagoon thus gradually fills up with fine mud partly composed of organic material. In the case under consideration, the black clay represents this period. During this time the mussels flourished in the still water. Finally the lagoon or "slough" became dry land, this being the ordinary result of the process.

The naiad fauna of the Fish-house deposit is precisely similar in general character to that of the "sloughs" of the Mississippi River to-day.

The cap of sand upon the black clay may be regarded as a later deposition of more general geographic distribution, while the formations it overlies in this place are believed to be the result of strictly local causes, and antedating by a lapse of time, greater or less in duration, the overlying gravels.

As to the fossils themselves, it must be admitted that their divergence from living forms is very slight in most cases—a fact which Dr. Lea significantly indicated by his choice of specific names. Some of the species are really not distinguishable from modern shells. Thus *Unio nasutoides* has no characters which can not be readily paralleled in the living *Unio nasutus* or *fisherianus*. *Anodonta corpulentooides* is equally indistinguishable from *A. corpulenta*. The absolute counterpart of *Unio radiatooides* may be selected from any collection of *U. radiatus*, and so on. The remarkable feature of the series of fossil forms is that certain of them have no modern representatives in the Atlantic drainage south of the Great Lake and St. Lawrence system. The following "species" exemplify this statement: *U. ligamentinoides*, *alatooides*, *præanodontoides*, *rectoides*, *Anodonta grandiooides* and *corpulentooides*. Although the affinities of some of these may have been wrongly estimated, owing to imperfection of the specimens, still a portion of them unquestionably bears out the relationships affirmed by Dr. Lea. The majority of these species foreign to the modern Atlantic drainage have their living allies in, or are identical with, species of the Great Lake system, extending also into the northern Mississippi drainage in which, more-

over, they are better developed. Still, the characteristic Mississippi River types of *Unionidæ* are not represented in the Fish-house fauna. None of the triangular or round Unios with heavy teeth are found; no member of the great tuberculate or plicate groups occur. The Fish-house fauna is therefore to be assimilated rather with the Great Lake system than with the Mississippi or Ohio drainages. The species probably found their way into the Atlantic system in New York State, where the Lake and Atlantic waters are in close proximity. They may then have become extinct on the Atlantic slope during the glacial period when the rivers north of Delaware Bay were so profoundly affected.<sup>7</sup>

*Summary.*—The writer has attempted to show (1) that the Fish-house clay is a Pleistocene deposit, as held by Lewis, White and some others, not belonging to the Cretaceous or Tertiary as Lea, Whitfield and other geologists have claimed; (2) that it is either interglacial or preglacial, and probably the latter; (3) that it is purely local and fluvial; and (4) that the structure of the sand underlying the clay, now first made known, gives a clue to the true explanation of the several geologic features of the deposit.

The position of this deposit in the post-Pliocene series is one of some difficulty, but materials bearing upon the question are not wanting. We know that the immediately post-glacial mollusk fauna of New Jersey was similar to the modern, except that it contained forms of more northern distribution; but there were no distinctively trans-Alleghenian types such as the Fish-house beds contain.<sup>8</sup> The very different character of the latter fauna would therefore indicate an earlier period. It was therefore either interglacial or preglacial, and the divergence of a part of the species from the most allied living forms, as well as the fact that the fauna was an abundant one, composed of large and well-developed individuals, point rather to preglacial than to interglacial conditions.

---

<sup>7</sup> Those interested in the former distribution eastward of the trans-Alleghenian *Unionidæ* should consult Simpson, On some Fossil Unios from the Drift at Toronto, Canada. Proc. U. S. Nat. Mus., XVI, p. 591.

<sup>8</sup> White Pond, in Sussex Co., N. J., a typically glacial lake, furnishes abundant evidence in support of the above statement, and also shows the changes which have taken place from post glacial to recent times in the mollusk fauna. This evidence the writer proposes to publish as soon as engagements permit.